



April 18, 2000

Mr. William Grimly / Ms. Lara Autry
Emissions Measurement Center (MD-19)
U.S. Environmental Protection Agency
Interstate 40 and Page Road
Room Number E-108
Durham, N. C. 27711

Dear Mr. Grimly and Ms. Autry:

In response to the U.S. Environmental Protection Agency Mercury Information Collection Request for electric utilities, mercury speciation stack testing at Kansas City Power & Light Company's (KCPL), Montrose Generating Station, Unit Number 1 were conducted on January 18 and 19, 2000.

I am enclosing three copies of the final test report (two bound and one unbound) prepared by METCO Environmental. If there are any questions regarding this report please feel free to contact me, or the individuals listed on page 1-2 of the report.

Sincerely,

A handwritten signature in black ink, appearing to read "Dan Haas". The signature is fluid and cursive, with the first and last names being clearly legible.

Dan Haas
Environmental Services Department

Enclosures (3)

cc: D. Kelsay, Montrose
B. Hefley, Metco Environmental (w/o enclosure)
T. Eaton, KCPL (w/o enclosure)



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SOURCE EMISSIONS SURVEY
OF
KANSAS CITY POWER & LIGHT COMPANY
MONTROSE GENERATING STATION
UNIT NUMBER 1 EAST PRECIPITATOR INLET DUCT
AND UNIT NUMBER 1 STACK
CLINTON, MISSOURI
FOR
ELECTRIC POWER RESEARCH INSTITUTE

JANUARY 2000

FILE NUMBER 99-95MON1

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1 INTRODUCTION

1.1 Summary of Test Program

METCO Environmental, Dallas, Texas, conducted a source emissions survey of Kansas City Power & Light Company, Montrose Generating Station, located in Clinton, Missouri, for the Electric Power Research Institute, on January 18 and 19, 2000. The purpose of these tests was to meet the requirements of the EPA Mercury Information Request. Speciated mercury concentrations at the Unit Number 1 East Precipitator Inlet Duct, speciated mercury emissions at the Unit Number 1 Stack, and mercury and chlorine content of the fuel were determined. The sulfur, ash, and Btu content of the fuel were also determined.

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999; and ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286.

1.2 Key personnel

Mr. Bill Hefley of METCO Environmental was the onsite project manager. Mr. Shane Lee, Mr. Mike Bass, Mr. Jason Conway, Mr. Scott Hart, and Mr. Jason Brown of METCO Environmental performed the testing.

Mr. David Kelsay of Kansas City Power & Light Company acted as the utility representative and performed process monitoring and sampling.

Mr. Paul Chu was the Electric Power Research Institute project manager.

Table 1-1
Test Program Organization

Organization	Individual	Responsibility	Phone Number
<i>Project Team</i> METCO	Bill Hefley	Project Manager	(972) 931-7127
<i>Utility</i> K.C.P.&L.	David Kelsay	Utility Representative & Process Monitoring	(660) 885-2284
<i>QA/QC</i> EPRI	Paul Chu	Project Manager	(650) 855-2812

2 SOURCE AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

Kansas City Power & Light, Montrose Generating Station, Unit Number 1 began commercial operation in 1958. The steam generator, designed by CE (Combustion Engineering), burns pulverized coal and is tangentially fired. The furnace is divided into two halves by a bank of tubes known as a curtain wall. Three boiler circulation pumps circulate the water through the boiler tubes, which make up the bulk of the furnace walls. Unit Number 1 was originally designed to burn high-sulfur bituminous coal.

In the late 1980's, Unit Number 1 was converted to burn Powder River Basin (sub-bituminous) coal from Wyoming. The coal comes to the station in unit trains consisting of 100-110 coal cars each carrying approximately 100 tons of coal. The coal is broken at the mine to a size of 3 inches or less. The mine is also responsible for sampling the coal for the traditional parameters of Btu, sulfur, ash, etc. Once the unit train arrives at the station, it is unloaded at the station rotary dumper. The cars are unloaded by inverting them in place without uncoupling, one car at a time, in a process that can unload a 100-car train in approximately 4 hours. The coal falls down into a hopper where it is moved by belt to an on-ground storage area. From there it is moved by another belt to the bunker room where it is dropped into one of fifteen coal bunkers (five of these bunkers belonging to Unit 1). By the time the coal reaches the bunkers for storage, the only treatment the coal will have received is the addition of water for dust suppression, and possibly the addition of small amounts of either ethylene glycol to prevent frost on the belts and/or organic-based dust suppression chemicals.

Unit 1 has five coal bunkers. At the bottom of each coal bunker is a coal feeder which regulates the amount of coal that is dropped into one of five coal mills, or pulverizers. The coal feeder has an electronically controlled, variable speed motor that controls the amount of coal from the bunker that is allowed to reach the pulverizer. The coal feeder can operate in either an automatic mode, where the boiler control system regulates the signal to the variable speed motor, or it can operate in a manual mode, in which case the control room operator can control the signal to the motor. The coal feeder has a hinged door, which can be opened while it is in operation that provides access to the entire stream of the flowing coal. This was the point where the coal was sampled for the mercury testing.

Once the coal reaches the pulverizer, it is ground to face powder consistency by three rollers on the mill. The coal is then blown into the furnace by one of two forced draft fans, which supplies air to the five coal pulverizers. This air provides part of the combustion air needed to burn the coal. The air to the mills will have passed through one of two air heaters. The air heater consists of a large rotating element containing metal baskets. The baskets pick up heat from the flue gas departing the furnace and transfer the heat to the air supplied to the coal mills. Pre-heating the air improves the grinding ability of the pulverizer by drying the coal. In colder weather, additional heat is supplied by duct burners, which burn fuel oil to further warm the air supplied to the coal mills. The gases produced by the duct burners exhaust into the furnace.

Air passing through the coal pulverizers is known as primary air. Not all the air from the forced draft fans passes through the pulverizers. Through a set of dampers, part of the air from the forced draft fans is diverted to the burner section of the furnace to help improve overall combustion efficiency.

This diverted air is known as secondary air. The combustion control process attempts to provide sufficient air to burn all the coal entering the furnace, while at the same time minimizing the amount of air passing through the furnace. This maximizes the heat transferred to water and steam cooled boiler tubes, and minimizes the amount of heat that goes up the stack.

After the pulverized coal is blown into the furnace it is combusted at the burner level. The angle at which the coal is injected into the furnace is designed to create two swirling fireballs, one in each half of the furnace. After the coal is burned, the flue gases that are created rise up in the boiler, turn the corner at the top of the boiler and proceed down the back-pass area. Throughout this area, water-cooled and steam-cooled tubes are absorbing heat from the combustion process. From the back-pass, the path of the flue gases bends to go into the air heaters, and then into the precipitators. From there the flue gases go through the induced draft fans (discussed below) and into the stack from which it exits at an altitude approximately 450 feet above ground level.

A second set of two fans is located at the outlet of the precipitators. These fans are called induced draft (ID) fans. They act to pull the air from the furnace through the air heaters and precipitators and exhaust that air into the Unit 1 stack. The Unit 1 boiler control system regulates the flow of air through the induced draft fans versus the forced draft fans via fan dampers to maintain a slight negative air pressure inside the furnace relative to atmospheric pressure.

2.2 Control Equipment Description

Three types of ash are produced in the furnace once the coal is burned. One type is bottom ash. This consists of a slag-type material that falls to the bottom of the boiler, where it is ground up by clinker grinders.

The material now has a sandy consistency and is sluiced by water to dewatering bins, where the water is drained off. This material is then hauled by truck to the station ash landfill.

A second type of ash is referred to as economizer ash. The flue gas passing through the furnace, passing through the back-pass section initially entrains this ash. This material has enough density that it falls into storage hoppers known as economizer hoppers, before the flue gas stream turns to enter the air heater. The economizer ash is disposed of in the ash landfill.

The third type of ash is referred to as fly ash. This material consists of a fine dust, and is entrained in the flue gas stream until it reaches the electrostatic precipitators downstream of the air heater. The precipitators apply an electric charge to the fly ash particles, which causes more than 99% of the fly ash particles to fall out of the flue gas stream into hoppers below the precipitators. A substantial portion of the fly ash is sold to vendors for concrete production; the remainder is disposed of in the ash landfill.

2.3 Flue Gas and Process Sampling Locations

2.3.1 Inlet Sampling Location

The sampling location on the Unit Number 1 East Precipitator Inlet Duct is 13 feet above the ground. The sampling locations are located 6 feet 6 1/2 inches (0.91 equivalent duct diameters) downstream from a bend in the duct and 10 feet 3 1/2 inches (1.44 equivalent duct diameters) upstream from a bend in the duct.

2.3.2 Stack Sampling Location

The sampling location on the Unit Number 1 Stack is 285 feet above the ground. The sampling locations are located 251 feet 3 inches (20.97 stack diameters) downstream from the inlet to the stack and 138 feet 9 inches (11.58 stack diameters) upstream from the outlet of the stack.

2.3.3 Coal Sampling Location

The coal sampling locations are located at the inlet of each individual feeder.

Figure 2-1
Description of sampling locations at Montrose Unit Number 1 East Precipitator Inlet Duct

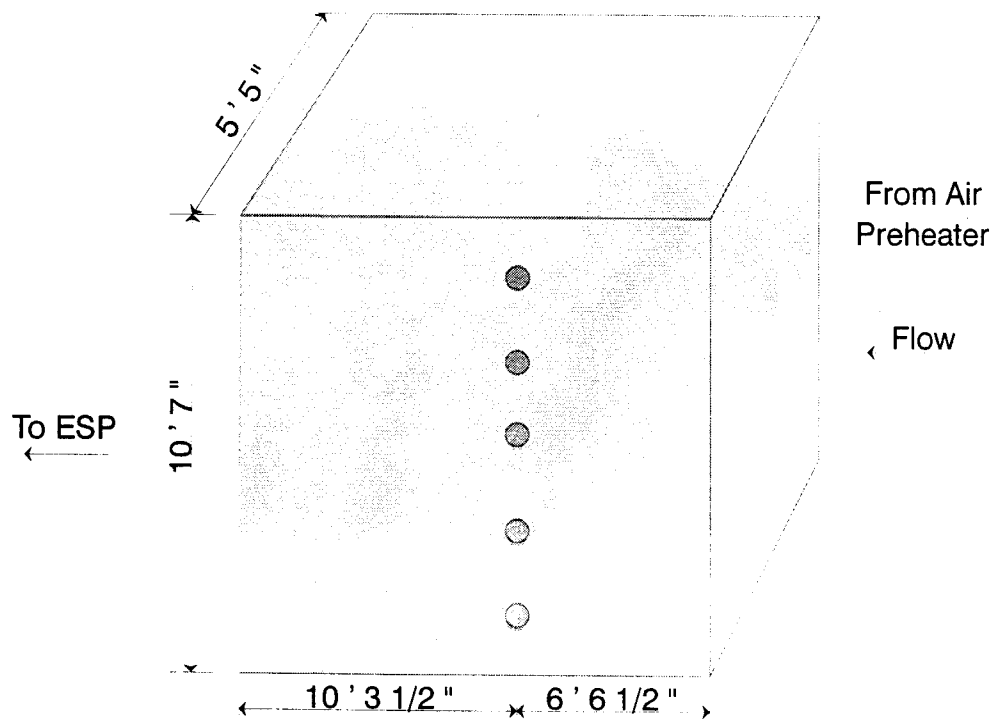


Figure 2-2
Description of sampling points at Montrose Unit Number 1 East Precipitator Inlet Duct

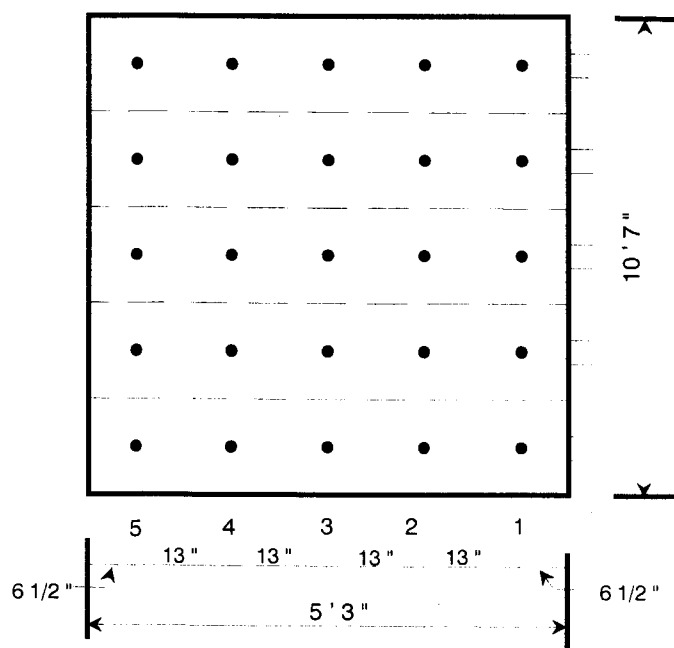


Figure 2-3
Description of sampling locations at Montrose Unit Number 1 Stack

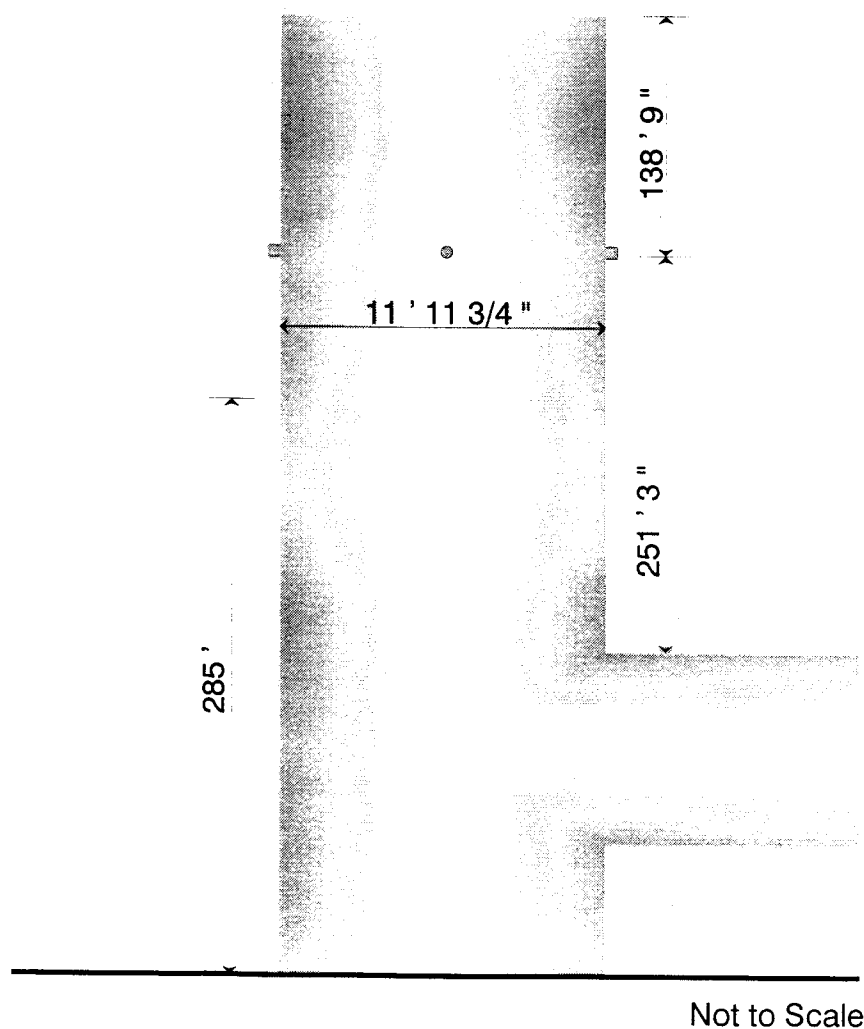
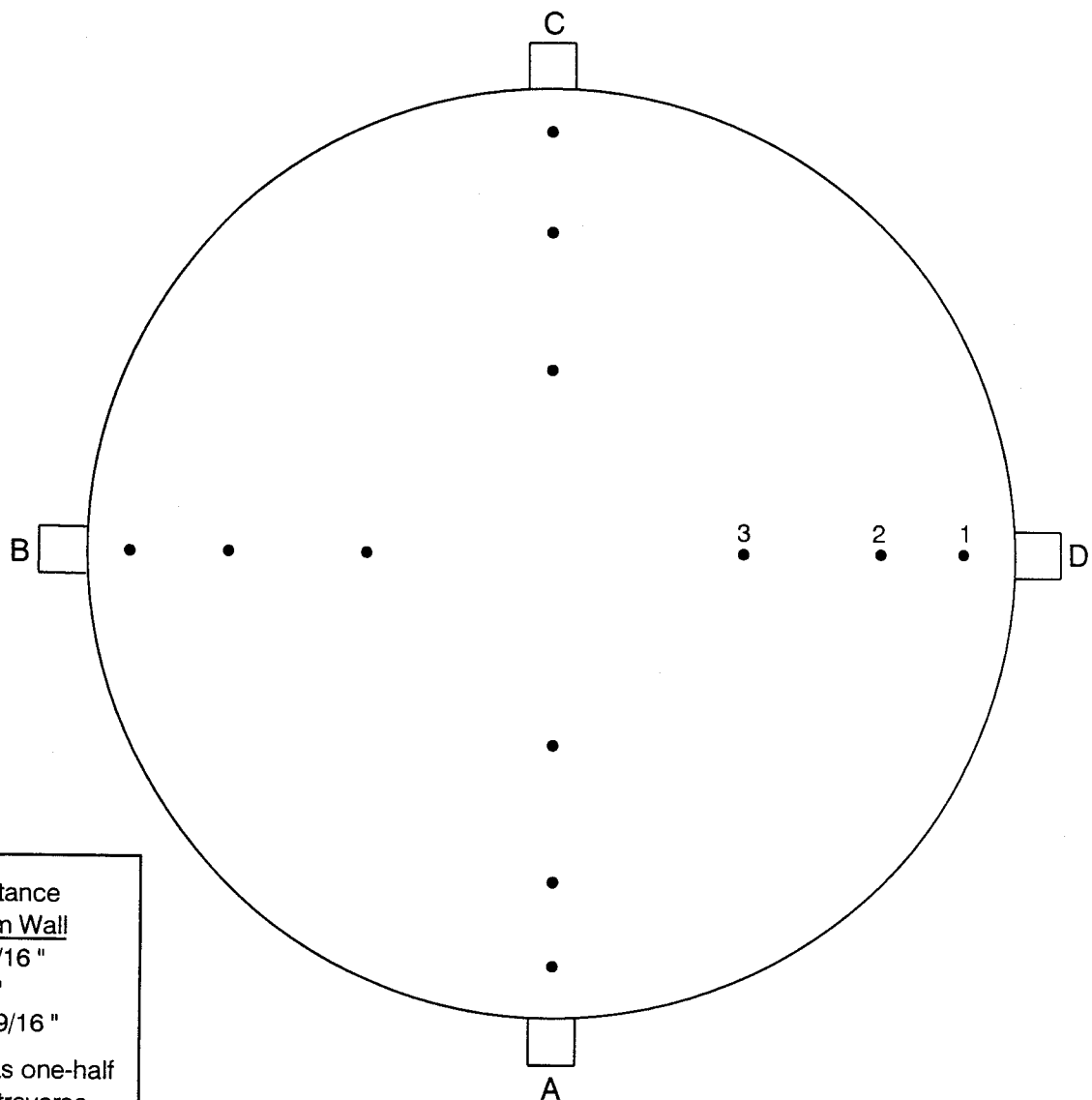


Figure 2-4
Description of sampling points at Montrose Unit Number 1 Stack



<u>Point*</u>	<u>Distance from Wall</u>
1	6 5/16 "
2	21 "
3	42 9/16 "

*Calculated as one-half
of a six point traverse.

Figure 2-5
Description of coal feeder sampling locations at Montrose Unit Number 1

Mill Sampling Location



Boiler

Air Heaters

ESP

Stack

3 SUMMARY AND DISCUSSION OF RESULTS

3.1 Objectives and Test Matrix

3.1.1 Objective

The objective of the tests was to collect the information and measurements required by the EPA Mercury ICR. Specific objectives listed in order of priority are:

1. Quantify speciated mercury emissions at the stack.
2. Quantify speciated mercury concentrations in the flue gas at the inlet.
3. Quantify fuel mercury and chlorine content during the stack and inlet tests.
4. Provide the above information for use in developing boiler, fuel, and specific control device mercury emission factors.

3.1.2 Test Matrix

The test matrix is presented in Table 1. The table includes a list of test methods to be used. In addition to speciated mercury, the flue gas measurements include moisture, flue gas flow rates, carbon dioxide, and oxygen.

Table 3-1
Test Matrix for Mercury ICR Tests at Montrose Unit Number 1

Sampling Location	No. of Runs	Species Measured	Sampling Method	Sample Run Time	Analytical Method	Analytical Laboratory
Stack	3	Speciated Hg	Ontario Hydro	120 min	Ontario Hydro	TestAmerica
Stack	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Stack	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Stack	3	O ₂ & CO ₂	EPA 3B	Concurrent	Orsat	METCO
Inlet	3	Speciated Hg	Ontario Hydro	120 min	Ontario Hydro	Test America
Inlet	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Inlet	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Inlet	3	O ₂ & CO ₂	EPA 3B	Concurrent	Orsat	METCO
Feeder	3	Hg, Cl, Sulfur, Ash, and Btu/lb in coal	ASTM D2234	1 grab sample every 30-minutes per feeder per run	ASTM D6414-99 (Hg), ASTM E776/300.0 (Cl), ASTM D-4239 (S), ASTM D-3174 (Ash), and ASTM D-3286 (Btu/lb)	TestAmerica and Philip Services

3.2 Field Test Changes and Problems

No deviations were made from the approved Sampling and Analytical Test Plan.

3.3 Handling of Non-Detects

This section addresses how data will be handled in cases where no mercury is detected in an analytical fraction. It should be noted that the analytical method specified in the Ontario Hydro Method has a very low detection limit, which is expected to be well below flue gas levels for most cases if the laboratory uses normal care and state of the art analytical equipment. However, there may be cases where certain fractions of a test do not show detectable mercury levels. This section addresses how non-detects will be handled in calculating and reporting mercury levels.

3.3.1 A single analytical fraction representing a subset of a mercury species is not detected.

When more than one sample component is analyzed to determine a mercury species (such as analyzing the probe rinse and filter catch separately to determine total particulate mercury) and one fraction is not detected, it will be counted as zero. Total mercury for that species will be the sum of the detected values of the remaining fraction(s). For example, if the probe rinse had ND < 0.05 µg and the filter had 1.5 µg, total particulate mercury would be reported as 1.5 micrograms.

3.3.2 All fractions representing a mercury species are not detected.

If all fractions used to determine a mercury species are not detected, the total mercury for that species will be reported as not detected, at the sum of the detection limits of the individual species.

For example, if the probe rinse were not detected at 0.003 μg and the filter catch were not detected at 0.004 μg , the reported particulate mercury would be reported as ND < 0.007 μg . This is expected to represent a small fraction (<1%) of the total mercury, even under worse case scenario of 1 $\mu\text{g}/\text{Nm}^3$.

3.3.3 No mercury is detected for a species on all three test runs.

When all three test runs show no detectable levels of mercury for a mercury species, that mercury species will be reported as not detected at less than the highest detection limit. For example, if three results for elemental mercury are ND < 0.10, ND < 0.13, and ND < 0.10, the results would be reported as ND < 0.13 (the highest of the three detection levels).

In calculating total mercury, a value of zero will be used for that species. For example, if particulate mercury were ND < 0.11 μg , oxidized mercury were 2.0 μg , and elemental mercury were 3.0 μg , total mercury would be reported as 5.0 μg .

In calculating the percentage of mercury in the other two species, a value of zero will be used. For the example listed in the preceding paragraph, the results would be reported as 0% particulate mercury, 40% oxidized mercury, and 60% elemental mercury.

3.3.4 Mercury is detected on one or two of three runs.

If mercury is detected on one or two of three runs, average mercury will be calculated as the average of the detected value(s) and half of the detection limits for the non-detect(s).

Example 1: The results for three runs are 0.20, 0.20, and ND < 0.10. The reported value would be calculated as the average of 0.20, 0.20, and 0.05, which is 0.15 μg .

Example 2: The results for three runs are 0.14, ND < 0.1, and ND < 0.1. The average of 0.14, 0.05, and 0.05 is calculated to be 0.08. Since this is below the detection limit of 0.1, the reported value is ND < 0.1.

3.4 Summary of Results

The results of the tests performed at Montrose Unit Number 1 are listed in the following tables.

Table 3-2
Montrose Unit Number 1 Source Emissions Results

Run Number	1	2	3
Test Date	01/18/00	01/19/00	01/19/00
Test Time	1315-1710	0900-1115	1230-1443
Inlet Gas Properties			
Flow Rate – ACFM	159,043	164,676	165,444
Flow Rate – DSCFM*	93,043	93,874	93,571
% Water Vapor - % Vol.	11.05	11.29	11.37
CO ₂ - %	14.4	15.2	15.4
O ₂ - %	5.2	4.6	4.2
% Excess Air @ Sampling Point	32.3	27.6	24.6
Temperature - °F	312	316	323
Pressure – "Hg	28.67	28.15	28.21
Percent Isokinetic	95.1	98.1	99.0
Volume Dry Gas Sampled – DSCF*	57.420	59.778	60.092
Stack Gas Properties			
Flow Rate – ACFM	669,477	706,158	700,596
Flow Rate – DSCFM*	391,903	407,736	396,351
% Water Vapor - % Vol.	10.41	10.74	11.17
CO ₂ - %	11.6	13.2	13.8
O ₂ - %	6.8	6.6	6.0
% Excess Air @ Sampling Point	45.9	45.0	39.3
Temperature - °F	331	334	334
Pressure – "Hg	29.18	29.00	28.55
Percent Isokinetic	91.9	100.7	100.6
Volume Dry Gas Sampled – DSCF*	61.646	70.303	68.233

* 29.92 "Hg, 68 °F (760 mm Hg, 20 °C)

Table 3-3
Montrose Unit Number 1 Mercury Removal Efficiency

Run Number	1	2	3	Average
Test Date	01/18/00	01/19/00	01/19/00	
Test Time	1315-1710	0900-1115	1230-1443	
Total mercury				
Inlet - lb/10 ¹² Btu	7.06	6.03	6.59	6.56
Stack - lb/10 ¹² Btu	5.82	6.16	5.77	5.92
Removal efficiency - %	17.6	-----	12.4	9.9
Particulate mercury				
Inlet - lb/10 ¹² Btu	1.40	0.65	1.17	1.07
Stack - lb/10 ¹² Btu	0.019	0.014	0.014	0.016
Removal efficiency - %	98.6	97.8	98.8	98.5
Oxidized mercury				
Inlet - lb/10 ¹² Btu	1.33	1.82	2.05	1.73
Stack - lb/10 ¹² Btu	1.85	1.87	1.66	1.79
Removal efficiency - %	-----	-----	19.0	-----
Elemental mercury				
Inlet - lb/10 ¹² Btu	4.32	3.55	3.37	3.75
Stack - lb/10 ¹² Btu	3.95	4.28	4.09	4.11
Removal efficiency - %	8.6	-----	-----	-----

Table 3-4
Montrose Unit Number 1 Mercury Speciation Results

Run Number	1	2	3	Average
Test Date	01/18/00	01/19/00	01/19/00	
Test Time	1315-1710	0900-1115	1230-1443	
South Inlet Mercury Speciation				
Particulate mercury - µg	2.77	1.40	2.59	—
µg/dscm	1.70	0.83	1.52	1.35
lbs/10 ¹² Btu	1.40	0.65	1.17	1.07
% of total Hg	19.8	10.8	17.8	16.1
Oxidized mercury - µg	2.64	3.90	4.53	—
µg/dscm	1.62	2.30	2.66	2.19
lbs/10 ¹² Btu	1.33	1.82	2.05	1.73
% of total Hg	18.8	30.2	31.1	26.7
Elemental mercury - µg	8.57	7.60	7.44	—
µg/dscm	5.27	4.49	4.37	4.71
lbs/10 ¹² Btu	4.32	3.55	3.37	3.75
% of total Hg	61.2	58.8	51.1	57.0
Total mercury - µg	13.99	12.91	14.56	—
µg/dscm	8.60	7.63	8.56	8.26
lbs/10 ¹² Btu	7.06	6.03	6.59	6.56
South Stack Mercury Speciation				
Particulate mercury - µg	0.038	0.030	0.032	—
µg/dscm	0.022	0.015	0.017	0.018
lbs/10 ¹² Btu	0.019	0.014	0.014	0.016
% of total Hg	0.3	0.2	0.2	0.2
Oxidized mercury - µg	3.54	4.14	3.71	—
µg/dscm	2.03	2.08	1.92	2.01
lbs/10 ¹² Btu	1.85	1.87	1.66	1.79
% of total Hg	31.8	30.4	28.8	30.3
Elemental mercury - µg	7.54	9.45	9.15	—
µg/dscm	4.32	4.75	4.74	4.60
lbs/10 ¹² Btu	3.95	4.28	4.09	4.11
% of total Hg	67.9	69.5	70.9	69.4
Total mercury - µg	11.12	13.62	12.89	—
µg/dscm	6.37	6.84	6.67	6.63
lbs/10 ¹² Btu	5.82	6.16	5.77	5.92
Coal Analysis				
Mercury - ppm dry	0.089	0.107	0.103	0.100
Mercury - lbs/10 ¹² Btu	9.93	12.46	11.94	11.44
Chlorine - ppm dry	200	100	100	133
Moisture - %	16.6	15.7	17.4	16.6
Sulfur - % dry	0.20	0.20	0.21	0.20
Ash - % dry	4.81	5.72	5.00	5.18
HHV - Btu/lb as fired	8,710	8,690	8,660	8,687
Coal flow - lbs/hr as fired	184,975	184,750	183,735	184,487
Total Heat Input - 10 ⁶ Btu/hr	1,611	1,605	1,591	1,602
Total Mercury Mass Rates				
lbs/hr input in coal	0.016	0.020	0.019	0.018
lbs/hr at Precipitator Inlet	0.011	0.010	0.010	0.010
lbs/hr emitted	0.009	0.010	0.010	0.010

Table 3-5
Montrose Unit Number 1 Process Data

Run Number	1	2	3
Test Date	01/18/00	01/19/00	01/19/00
Test Time	1315-1710	0900-1115	1230-1443
Unit Operation			
Unit Load - MW gross	163.9	163.7	162.8
Coal Flow - lbs/hr	184,975	184,750	183,735
CEMS data			
CO ₂ - %	12.54	12.28	12.30
SO ₂ – lbs/10 ⁶ Btu	0.445	0.457	0.445
NO _x – lbs/10 ⁶ Btu	0.281	0.284	0.287
Stack Temperature - °F	330.3	333.8	337.8
Stack flow – kscfm	433	437	432
Opacity - %	15.05	17.28	16.43

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Emission Test Methods

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999 and ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286.

A preliminary velocity traverse was made at each of the five ports on the Unit Number 1 East Precipitator Inlet Duct, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 7.7 degrees. Alternate procedures would be required if the angle of cyclonic flow were greater than 20 degrees. Five traverse points were sampled from each of the five ports for a total of twenty-five traverse points at the inlet duct sampling location.

A preliminary velocity traverse was made at each of the four ports on the Unit Number 1 Stack, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 0.8 degrees. Alternate procedures would be required if the angle of cyclonic flow were greater than 20 degrees. Three traverse points were sampled from each of the four ports for a total of twelve traverse points at the stack sampling location.

The sampling trains were leak-checked at the end of the nozzle at 15 inches of mercury vacuum before each test, and again after each test at the highest vacuum reading recorded during each test. This was done to predetermine the possibility of a diluted sample.

The pitot tube lines were checked for leaks before and after each test under both a vacuum and a pressure. The lines were also checked for clearance and the manometer was zeroed before each test.

Integrated orsat samples were collected and analyzed according to EPA Method 3B during each test.

4.1.1 Mercury

Triplicate samples for mercury were collected. The samples were taken according to EPA Methods 1, 2, 3B, 4, 5 and 17; and the Ontario Hydro Method, Revised July 7, 1999. For each run at the inlet sampling location, samples of five-minute duration were taken isokinetically at each of the twenty-five traverse points for a total sampling time of 125 minutes. For each run at the stack sampling location, samples of ten-minute duration were taken isokinetically at each of the twelve sampling points for a total sampling time of 120 minutes. Data was recorded at five-minute intervals. Reagent blanks and field blanks were submitted.

The "front-half" of the sampling train at the inlet sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Thimble and Backup Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "front-half" of the sampling train at the stack sampling location contained the following components:

Teflon Coated Nozzle
In-stack Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "back-half" of the sampling train at both sampling locations contained the following components:

<u>Impinger Number</u>	<u>Impinger Type</u>	<u>Impinger Contents</u>	<u>Amount</u>	<u>Parameter Collected</u>
1	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
2	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
3	Greenburg-Smith Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
4	Modified Design	5% HNO ₃ and 10% H ₂ O ₂	100 ml	Elemental Mercury and Moisture
5	Modified Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
6	Modified Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
7	Greenburg-Smith Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
8	Modified Design	Silica	200 g	Moisture

All glassware was cleaned prior to use according to the guidelines outlined in EPA Method 29, Section 5.1.1 and the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.15. All glassware connections were sealed with Teflon tape.

At the conclusion of each test, the filter and impinger contents were recovered according to procedures outlined in the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.

Mercury samples were analyzed by Cold Vapor Atomic Absorption and Fluorescence Spectroscopy.

4.2 Process Test Methods

ASTM D2234 method of coal sampling was followed. For each test run, a grab sample of coal was collected from the inlet of each individual feeder. One composite sample was prepared for analysis from the individual feeder samples. Each sample was analyzed for mercury, chlorine, sulfur, ash, and Btu content by ASTM Methods D6414-99, E766/300.0, D-4239, D-3174, and D-3286, respectively.

4.3 Sample Tracking and Custody

Samples and reagents were maintained in limited access, locked storage at all times prior to the test dates. While on site, they were at an attended location or in an area with limited access. Off site, METCO and TestAmerica provided limited access, locked storage areas for maintaining custody.

Chain of custody forms are located in Appendix F. The chain of custody forms will provide a detailed record of custody during sampling, with the initials noted of the individuals who load and recover impingers and filters and perform probe rinses.

All samples were packed and shipped in accordance with regulations for hazardous substances.

5 QA/QC ACTIVITIES

The major project quality control checks are listed in Table 5-1. Matrix Spike Summaries are listed in Table 5-2. Duplicate and Triplicate Analyses Summaries are listed in Table 5-3. Additional method-specific QC checks are presented in Table 5-4 (Methods 1 and 2), Table 5-5 (Method 5/17 sampling), and Table 5-6 (Ontario Hydro sample recovery and analysis). These tables also include calibration frequency and specifications.

Table 5-1
Major Project Quality Control Checks

<i>QC Check</i>	<i>Information Provided</i>	<i>Results</i>
<i>Blanks</i>		
Reagent blank	Bias from contaminated reagent	Low levels of mercury were detected
Field blank	Bias from handling and glassware	Low levels of mercury were detected
<i>Spikes</i>		
Matrix spike	Analytical bias	Sample results were between 75% - 125% recovery
<i>Replicates</i>		
Duplicate analyses	Analytical precision	Results were < 10% RPD
Triplicate analyses	Analytical precision	Results were < 10% RPD

Table 5-2
Matrix Spike Summary

<i>Sampling Location</i>	<i>Run Number</i>	<i>Container</i>	<i>Results (μg)</i>	<i>True Value (μg)</i>	<i>Recovery (%)</i>
Inlet Duct	2	1B	0.0505	0.050	101
Inlet Duct	3	4	0.372	0.452	82
Inlet Duct	3	5	4.46	4.40	101
Stack	1	1A	0.151	0.150	103
Stack	3	2	0.171	0.147	116
Stack	3	3	0.89	1.09	82
Stack	3	4	0.401	0.464	86
Stack	3	5	5.24	4.90	107

Table 5-3 Duplicate and Triplicate Analyses Summary

<i>Sampling Location</i>	<i>Run Number</i>	<i>Container</i>	<i>Results (µg)</i>	<i>Duplicate Results (µg)</i>	<i>RPD</i>	<i>Triplicate Results (µg)</i>	<i>RPD</i>
Inlet Duct	1	1A	2.73	2.73	0	----	----
		1B	0.005	0.005	0	----	----
		2	0.039	0.036	7.6	----	----
		3	2.64	2.59	1.6	----	----
		4	0.03	0.03	2.9	----	----
		5	8.54	8.25	3.4	----	----
	2	1A	1.40	1.40	0	----	----
		1B	0.004	0.004	4.8	----	----
		2	<0.012	<0.012	0	----	----
		3	3.90	3.76	3.5	----	----
		4	0.053	0.051	3.4	0.054	1.7
		5	7.55	7.30	3.3	7.5	<1.0
	3	1A	2.54	2.56	<1.0	----	----
		1B	0.005	0.005	2.2	----	----
		2	0.042	0.042	0	----	----
		3	4.53	4.56	<1.0	----	----
		4	0.048	0.044	9.8	----	----
		5	7.39	7.30	1.2	----	----
Stack	1	1A	0.000	0.000	0	----	----
		1B	0.008	0.008	0	0.008	0
		1B	0.005	0.005	0	----	----
		2	0.009	0.008	5.5	----	----
		3	3.54	3.56	<1.0	----	----
		4	0.033	0.032	1.3	----	----
		5	7.51	7.47	<1.0	----	----
	2	1A	0.011	0.011	0	----	----
		1B	<0.0025	<0.0025	0	----	----
		2	<0.011	<0.011	0	<0.011	0
		3	4.14	4.26	2.9	4.21	1.8
		4	0.044	0.042	4.3	0.043	2.1
		5	9.41	9.21	2.1	9.36	<1.0
	3	1A	0.006	0.006	0	----	----
		1B	0.007	0.008	4.6	----	----
		2	<0.007	<0.007	0	----	----
		3	3.71	3.71	0	----	----
		4	0.036	0.035	2.6	----	----
		5	9.11	8.92	2.2	----	----

Table 5-4
QC Checklist and Limits for Methods 1 and 2

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Measurement site evaluation	>2 diameters downstream and 0.5 diameters upstream of disturbances	Method 1, Section 2.1
Pitot tube inspection	Inspect each use for damage, once per program for design tolerances	Method 2, Figures 2-2 and 2-3
Thermocouple	+/- 1.5% (°R) of ASTM thermometer, before and after each test mobilization	Method 2, Section 4.3
Barometer	Calibrate each program vs. mercury barometer or vs. weather station with altitude correction	Method 2, Section 4.4

Although the Unit Number 1 East Precipitator Inlet Duct sampling location does not meet the requirements of Method 1, three-dimensional flow testing as described in Method 1 was not performed. A preliminary velocity traverse was made at each of the five ports on the Unit Number 1 East Preliminary Inlet Duct, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 7.7 degrees.

Table 5-5
QC Checklist and Limits for Method 5/17 Sampling

Quality Control Activity	Acceptance Criteria and Frequency	Reference
<i>Pre-mobilization checks</i>		
Gas meter/orifice check	Before test series, $Y_D \pm 5\%$ (of original Y_D)	Method 5, Section 5.3
Probe heating system	Continuity and resistance check on element	
Nozzles	Note number, size, material	
Glassware	Inspect for cleanliness, compatibility	
Thermocouples	Same as Method 2	
<i>On-site pre-test checks</i>		
Nozzle	Measure inner diameter before first run	Method 5, Section 5.1
Probe heater	Confirm ability to reach temperature	
Pitot tube leak check	No leakage	Method 2, Section 3.1
Visible inspection of train	Confirm cleanliness, proper assembly	
Sample train leak check	≤ 0.02 cf at 15" Hg vacuum	Method 5, Section 4.1.4
<i>During testing</i>		
Probe and filter temperature	Monitor and confirm proper operation	
Manometer	Check level and zero periodically	
Nozzle	Inspect for damage or contamination after each traverse	Method 5, Section 5.1
Probe/nozzle orientation	Confirm at each point	
<i>Post test checks</i>		
Sample train leak check	≤ 0.02 cf at highest vacuum achieved during test	Method 5, Section 4.1.4
Pitot tube leak check	No leakage	Method 2, Section 3.1
Isokinetic ratio	Calculate, must be 90-110%	Method 5, Section 6
Dry gas meter calibration check	After test series, $Y_D \pm 5\%$	Method 5, Section 5.3
Thermocouples	Same as Method 2	
Barometer	Compare w/ standard, ± 0.1 " Hg	

Table 5-6 QC Checklist and Limits for Ontario Hydro Mercury Speciation

Quality Control Activity	Acceptance Criteria and Frequency	Reference
<i>Pre-mobilization activities</i>		
Reagent grade	ACS reagent grade	Ontario Hydro Section 8.1
Water purity	ASTM Type II, Specification D 1193	Ontario Hydro Section 8.2
Sample filters	Quartz; analyze blank for Hg before test	Ontario Hydro Section 8.4.3
Glassware cleaning	As described in Method	Ontario Hydro Section 8.10
<i>On-site pre-test activities</i>		
Determine SO ₂ concentration	If >2500 ppm, add more HNO ₃ -H ₂ O ₂ solution	Ontario Hydro Section 13.1.13
Prepare KCl solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare HNO ₃ -H ₂ O ₂ solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare H ₂ SO ₄ -KMnO ₄ solution	Prepare daily	Ontario Hydro Section 8.5
Prepare HNO ₃ rinse solution	Prepare batch as needed; can be purchased premixed	Ontario Hydro Section 8.6
Prepare hydroxylamine solution	Prepare batch as needed	Ontario Hydro Section 8.6
<i>Sample recovery activities</i>		
Brushes and recovery materials	No metallic material allowed	Ontario Hydro Section 13.2.6
Check for KMnO ₄ Depletion	If purple color lost in first two impingers, repeat test with more HNO ₃ -H ₂ O ₂ solution	Ontario Hydro Section 13.1.13
Probe cleaning	Move probe to clean area before cleaning	Ontario Hydro Section 13.2.1
Impinger 1,2,3 recovery.	After rinsing, add permanganate until purple color remains to assure Hg retention	Ontario Hydro Section 13.2.8
Impinger 5,6,7 recovery.	If deposits remain after HNO ₃ rinse, rinse with hydroxylamine sulfate. If purple color disappears after hydroxylamine sulfate rinse, add more permanganate until color returns	Ontario Hydro Section 13.2.10
Impinger 8	Note color of silica gel; if spent, regenerate or dispose.	Ontario Hydro Section 13.2.11
<i>Blank samples</i>		
0.1 N HNO ₃ rinse solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
KCl solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
HNO ₃ -H ₂ O ₂ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
H ₂ SO ₄ -KMnO ₄ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Hydroxylamine sulfate solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Unused filters	Three from same lot.	Ontario Hydro Section 13.2.12
Field blanks	One per set of tests at each test location.	Ontario Hydro Section 13.4.1
<i>Laboratory activities</i>		
Assess reagent blank levels	Target <10% of sample value or <10x instrument detection limit. Subtract as allowed.	Ontario Hydro Section 13.4.1
Assess field blank levels	Compare to sample results. If greater than reagent blanks or greater than 30% of sample values, investigate. Subtraction of field blanks not allowed.	Ontario Hydro Section 13.4.1
Duplicate/triplicate samples	All CVAAS runs in duplicate; every tenth run in triplicate. All samples must be within 10% of each other; if not, recalibrate and reanalyze.	Ontario Hydro Section 13.4.1


6 DESCRIPTION OF TESTS

Personnel from METCO Environmental arrived at the plant at 7:30 a.m. on Tuesday, January 18, 2000. After meeting with plant personnel and attending a brief safety meeting, the equipment was moved onto the Unit Number 1 East Precipitator Inlet Duct and Unit Number 1 Stack. The equipment was prepared for testing and the preliminary data was collected. The first set of tests for mercury began at 1:15 p.m. and was completed at 5:10 p.m. The samples were recovered. The equipment was secured for the night. All work was completed at 6:30 p.m.

On Wednesday, January 19, work began at 7:00 a.m. The equipment was prepared for testing. The second set of tests for mercury began at 9:00 a.m. Testing continued until the completion of the third set of tests at 2:43 p.m.

The samples were recovered. The equipment was moved off of the sampling locations and loaded into the sampling van. The samples and the data were transported to METCO Environmental's laboratory in Dallas, Texas, for analysis and evaluation.

Operations at Kansas City Power & Light Company, Montrose Generating Station, Unit Number 1 East Precipitator Inlet Duct and Unit Number 1 Stack, located in Clinton, Missouri, for the Electric Power Research Institute, were completed at 5:00 p.m. on Wednesday, January 19, 2000.


Billy J. Mullins, Jr. P.E.
President